EFFECTS OF NUCLEATION AGENTS ON EFFICIENCY OF BORON EXTRACTION FROM $MgO-B_2O_3-SiO_2$ SLAGS①

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ABSTRACT

The effects of titania and the complex oxide as nucleation agents on the efficiency of boron extraction (EBE) from $MgO-B_2O_3-SiO_2$ slags were investigated by means of chemical analysis, polarization microscope and X-ray diffraction (XRD). The results showed that titania promoted the glass phase separation, thus increasing the crystallinity, therefore, the EBE were obviously improved. The complex oxide as nucleation agent had more remarkable effect than titania. Moreover, the lower the EBE was before addition of nucleation agents, the higher the EBE was increased after addition.

Key words: slag containing boron nucleation agent boron extraction

1 INTRODUCTION

It was indicated by further experiments[1,2] that the EBE were closely related to the slag compositions and cooling conditions. These factors can control the precipitating characteristics of the components containing boron in the slags. The EBE is high if the component containing boron exists in the form of $2MgO \cdot B_2O_3$, the EBE is low in the form of amorphous phase. However, the effects of nucleation agents on the precipitating process and the morphology of crystal are great[3-7], so the precipitating characteristics of the components containing boron can be manipulated and the crystallization is promoted by the addition of nucleation agents to the molten slag. As a result, the EBE is improved.

The purpose of the present work is to estimate the influences of nucleation agents on the EBE and is to select and optimize the nucleation agents.

2 EXPERIMENTAL

Raw materials: magnesia, silica, boron oxide, titania and the complex oxide are chemical reagents with analytical purity.

The chemical compositions of the slags selected for the present work are ternary system $MgO-B_2O_3-SiO_2$ in five series, as listed in Tabled 1.

Varying amounts of titania or the complex oxide as nucleation agents were added to the slags

Table 1 Chemical compositions of the slags $MgO-B_2O_3-SiO_2$ (wt. -%)

Number	MgO	SiO_2	B_2O_3
1	40	30	30
2	60	20	20
3	56	27.5	16.5
4	55.4	20.7	23.9
5	55	15.7	29.3

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$MgO-B_2O_3-SiO_2$, as given in Table 2.

Table 2 The slags $MgO-B_2O_3-SiO_2$ with different amouts of TiO_2 and the complex oxide as nucleation agents(wt. -%)

Number*	Slag	TiO_2	Complex oxide
n — 1	100	0	0
n — 2	99	1	0
n — 3	97	3	0
n — 4	99	0	1
n — 5	97	0	3

n = 1 ~ 5, where n is the number of the slags $MgO-B_2O_3-SiO_2$ listed in Table 1.

The slags were prepared using the oxide powders as raw materials. A homogeneous mixture in graphite crucible was quickly melted in an induction furnace at 1 500 ℃ and then was quenched in air to room temperature.

The slags were ground to powders for determination of the EBE by chemical analysis and of the X-ray diffraction characterization with X-ray (Cu K_α) powder diffractometer. The microstructures of the slags were observed by a polarization microscope under perpendicular-polarized light.

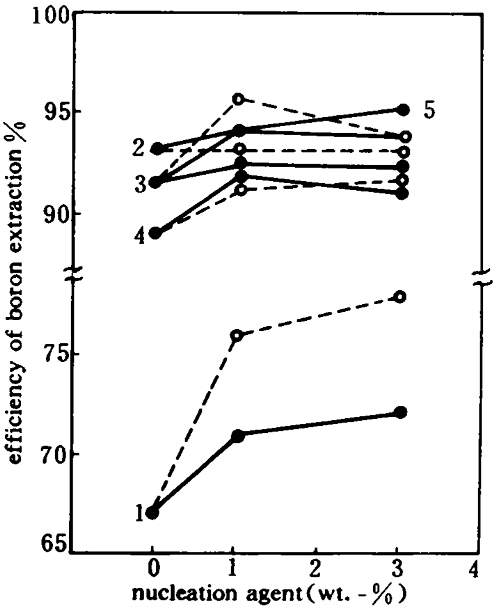


Fig. 1 The relation between the EBE and the amounts of nucleation agents

1, 2, 3, 4, 5 are the number of the slags in Table 1, respectivly

●—TiO_2; ○—the complex oxide

3 RESULTS AND DISCUSSION

The relation between the EBE and the amounts of nucleation agents is shown in Fig. 1. It indicates that the influences of the nucleation agents on the EBE are remarkable, especially, the EBE of sample No. 1 is obviously improved by the nucleation agents. The most part of the visual field in sample No. 1 is covered by glass phases (over 80%) in which a small number of the crystallites ($2MgO \cdot B_2O_3$) distributes (Fig. 2(a)). However, the addition of titania to the sample No. 1 caused the reducing by 20% glass phase and the growing of the cluster crystal (Fig. 2(b)). Similarly, the addition of the complex oxide to sample No. 1 facilitates the grain size of crystal coarsening and glass phase scattering (Fig. 2(c)). The XRD results also showed that it was a typical amorphous pattern for sample No. 1 without any nucleation agent, but the crystalline phases ($2MgO \cdot B_2O_3$ and $2MgO \cdot SiO_2$) were precipitated after the addition of nucleation agent, as seen in Fig. 3. Obviously, the nucleation agents can improve crystallization and increase the crystallinity of the slag, thereby the EBE increases.

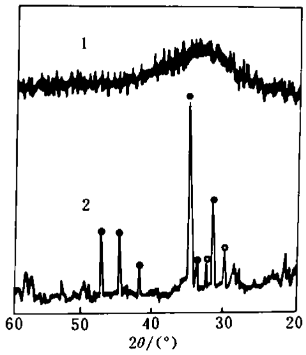
However, the increasing of EBE for sample No. 2~5 was not obvious as that for sample No. 1, since the EBE for sample 2~5 were already very high before the addition.

It is considered by scientists [8-11] that addition of titania promotes the nucleation through the phase separation and improves the crystallinity of the slags. Since the cation Ti^{4+}, which has small ionic radius and high electric charges as well as great field strength, may render the glass structure a intensive polymerization. These structure changes in which the cation may be associated in the network in the form of tetrahedron or dissociated from the network in the form of octahedron cause the reducing interface-energy of liquid- liquid phases, by that the glass phase separations are facilitated to some extent. On the other hand, the cation is prone to polarize the surrounding oxygen, thus forming a shield, so that the glass phase separation

Fig. 2 The microstructure of sample No. 1 (×140)
(a) — without any nucleation agent; (b) wth titania; (C) with complex oxide

is also accelerated. As the phase separation can provide the interface for heterogeneous nucleation, the crystal precipitation is inevitably promoted.

It is indicated by study [10] that the phase separation provides the driving force for the nucleation of glass crystallization and the interface which is a favourable place to form a crystal nuclei. Even within large supercooling region the phase separation enables the constituents of nucleation agents to accumulate in one of double phases, and then the crystallites are transformed from the liquid phase as crystal nuclei. Therefore, addition of nucleation agents promotes the glass phase separation, thus



Fg. 3 XRD pattern of sample No. 1
1 any nucleaton agent; 2 the complex oxide;
● $2MgO \cdot B_2O_3$; ○ $2MgO \cdot SiO_2$

increasing the crystallinities of the slags. As a result, the EBE is obviously improved.

REFERENCES

1 Zhang, Peixin *et al.* Transactions of Nonferrous Metals Society of China, 1994, 4(2): 38.
2 Zhang, Peixin *et al.* Nonferrous Metals, 1994, 46(2): 52.
3 Doherty P E; Lee D E; Davis R S. J Am Ceram Soc, 1967, 50(2): 77.
4 Maurer, R D. J Appl Phys, 1962, 33(6): 2132.
5 Yu, Zhichu; Zhu, Yonghua. Journal of Chinese Ceramic Society, 1988, 16(6): 501.
6 Jen-Yan Hsu; Speyer R F. J Am Ceram Soc, 1989, 72 (12): 2334.
7 Chen, Quanqing; Wang, Mingquan; Li, Daoping. Journal of Chinese Ceramic Society, 1988, 16(3): 193.
8 Yuan, Biao; Yu, Zhichu; Chen, Quanqing. Special Glasses, 1989, 6(1): 14.
9 Yuan, Biao. Glass Fibers, 1989, (2): 1.
10 Wang, Changwen; Huang, Xuewen. Bulletin of the Institute of Building Material Science, 1986, (3): 1.
11 Qiu, Guanming; Huang, Liangzhao. Science of Glass Formation. Beijing: Weapon Industry Press, 1987, 370.
12 Li, jiazhi. Journal of Chinese Ceramic Society, 1978, 6(4): 279.